sex-determination in the gamete, a discovery of astonishing novelty at that time, though now so familiar to us all that we have forgotten how hard it was to achieve. Being greatly struck with Wilson's cytological proof that many *male* insects are heterozygous for sex, and having himself proved that in Abraxas the female is in this condition, Doncaster devised a scheme in which both sexes are thus represented, dominance being attributed to the female gamete; but he afterwards accepted a simplifying emendation in which the male is taken to be homozygous. After this, finding a curious strain in which half the females produce daughters almost exclusively, Doncaster showed that these females generally had only fifty-five chromosomes instead of the normal fifty-six. By reasoning analogous to that afterwards used by Bridges in his famous paper on "non-disjunction," he attempted a cytological interpretation, though, as he admitted, the solution was imperfect, and the case is still mysterious.

Progress was also made with the paradox of tortoiseshell cats, known by fanciers to be almost exclusively females. Doncaster proved that tortoiseshell is the female heterozygote of orange and black, the corresponding male being orange; and in the course of wide inquiries he discovered the new fact that the rare tortoiseshell tom is often *sterile*. In his last paper he conjectured, not without probability, that, in view of Lillie's extraordinary discovery as to the free-martins of cattle, these males may owe their peculiarities to the intra-uterine influence of other embryos. Most of these subjects are discussed in his text-book, "The Determination of Sex," 1914. Just before his death Doncaster published an admirable "Introduction to the Study of Cytology," in which he declared himself with reservation a convert to the views of Morgan—a judgment which, from so critical an observer, must carry great weight.

His death will be cruelly felt. At a time when cytology is becoming a subject of primary importance, the loss first of R. P. Gregory and now of Doncaster leaves us bereft indeed.

Doncaster was one of the clearest-headed men I have known, and, being full of both enthusiasm and knowledge, he taught extraordinarily well. In Cambridge he served in various capacities, and was for four years in the University of Birmingham. As Prof. Herdman has written, his death is "nothing less than a calamity to Liverpool University." Doncaster was slight in figure and of a nervous temperament, feeling and thinking of everything with intensity, though nevertheless a fluent speaker. He came of a Quaker family, being the son of Samuel Doncaster, manufacturer, of Sheffield, in whose beautiful garden he developed his love of plants. Educated at the Friends' School at Leighton Park, Reading, he went up as a scholar to King's College, Cambridge, of which he afterwards became a fellow. He married in 1908 Dora, daughter of Walter Priestman, of Birmingham, and leaves three children.

We did not speak of such matters, but it was known to his friends that Doncaster had religious instincts strongly developed. The years of the war were to him more hateful even than to most thoughtful men. He held the Friends' attitude of the unlawfulness of war, but, feeling that alternative service was a duty, he gave up his researches and qualified as a bacteriologist, working in the 1st Eastern Hospital, Cambridge, and afterwards in the Friends' Ambulance Unit at Dunkirk.

W. Bateson.

Mr. John W. Hyatt, of Newark, New Jersey, whose death is reported at the age of eighty-two, was the inventor of celluloid. He was a printer by trade, and was using collodion in the course of his work when he accidentally overturned a bottle, and the idea of celluloid came to him from watching the collodion solidify. He took out 250 patents in all, a large majority of which had an important bearing on manufactures. They included a billiard-ball composition, a roller bearing, a system of purifying water for domestic use, a sewing machine capable of sewing fifty rows of lock-stitches at once, a machine for extracting juice from sugar cane, and a new method of solidifying American hardwoods. In 1914 Mr. Hyatt was awarded the Perkin medal of the New York Society of Chemical Industry.

We much regret to see the announcement in the *Times* that Prof. Augusto Righi, For. Mem. R.S., died suddenly at Bologna on June 8 at seventy years of age.

Notes.

The list of honours conferred in celebration of the King's Birthday includes the following names of men associated with scientific work:—*Irish Privy Councillor:* Mr. H. T. Barrie, Vice-President, Irish Department of Agriculture. *K.C.B.:* Sir A. W. Watson, president of the Institute of Actuaries. *C.B.:* Mr. A. W. Flux, Assistant Secretary, Board of Trade. *Baronet:* Mr. P. J. Mackie, who financed the Mackie Anthropological Expedition to Uganda and other expeditions. *Knights:* Prof. F. W. Andrewes, F.R.S., pathologist at St. Bartholomew's Hospital; Capt. D. Wilson-Barker, captain-superintendent of the training-ship *Worcester,* and past-president of the Royal Meteorological Society; Dr. J. C. Beattie, Principal of the University of the Cape of Good Hope; Mr. W. B. M. Bird, founder of the Salters' Institute of Industrial Chemistry; Dr. H. H. Hayden, Director of the Geological Survey of India; and Prof. J. B. Henderson, professor of applied mechanics, Royal Naval College, Greenwich. *C.I.E.:* Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, and Mr. R. S. Pearson, Forest Economist, Research Institute, Dehra Dun. *K.B.E.:* Dr. J. Dundas-Grant, eminent aural specialist; Dr. J. C. Stamp, distinguished economist; and Col. W. Taylor, ex-president of the Royal College of Surgeons in Ireland. *Companions of the Imperial Service Order:* Mr. R. B.

Newton, assistant in the Department of Geology, British Museum (Natural History); Dr. W. Eagle Clark, keeper of Natural History Department, Royal Scottish Museum, Edinburgh; and Mr. R. Duncan, Staff Officer, Veterinary Branch, Department of Agriculture and Technical Instruction, Ireland.

THE following decorations have been conferred upon scientific workers in recognition of valuable services rendered during the war, and the King has granted permission to wear them:—Conferred by the King of Italy—Order of the Crown of Italy: *Chevalier:* Mr. H. D. Roberts, director of Public Library, Museums, and Fine Art Galleries, Brighton. Order of St. Maurice and St. Lazarus: *Officer:* Sir Douglas Mawson, Dr. T. M. Lowry, F.R.S., and Prof. P. F. Frankland, F.R.S. Conferred by the King of the Belgians—Order of the Crown: *Grand Officer:* Sir Alfred Sharpe. *Commander:* Prof. W. Somerville. *Officer:* Dr. E. J. Russell, F.R.S. *Chevalier:* Mr. C. E. Fagan, Mr. A. R. Hinks, F.R.S., secretary of the Royal Geographical Society, and Mr T. McRow. Order of Leopold II.: *Commander:* Dr. W. R. Dunstan, F.R.S., director of the Imperial Institute, and Prof. G. H. F. Nuttall, F.R.S.

IT is announced in *Science* that the U.S. National Academy of Sciences has recently elected the following foreign associates:—Frank Dawson Adams, McGill University; Marie Ennemond Camille Jordan, Collège de France; François Antoine Alfred Lacroix, Musée d'Histoire Naturelle, Paris; Heike Kamerlingh Onnes, University of Leyden; Sir David Prain, Royal Botanic Gardens, Kew; and Santiago Ramon y Cajal, University of Madrid.

MR. O. F. BROWN, assistant inspector of wireless telegraphy in the Post Office, has been appointed Technical Officer to the Radio Research Board, which has been formed recently under the chairmanship of Admiral Sir Henry Jackson, in connection with the Department of Scientific and Industrial Research.

SIR W. J. POPE, F.R.S., was elected an associate of the section for the mathematical and physical sciences of the Académie Royale de Belgique on June 5.

COL. H. G. LYONS has been appointed director and secretary to the Science Museum, South Kensington, in succession to Sir Francis Ogilvie, who has been transferred to the Department of Scientific and Industrial Research.

PROF. FLINDERS PETRIE in *Ancient Egypt* (1920, part ii.) describes a remarkable statue of ebony 27 in. high. "The pose of the standing position is more thrown back than in the Old Kingdom, from the waist upward. The head has had inlaid eyes, now missing. The expression is marvellously vigorous and full of vitality, and it differs from other Egyptian figures not only thus, but also in the type. The very wide jaw, short chin, and high cheek-bone have hardly a parallel in other statues. It is clearly one of the great masterpieces, and of a rare style of work." It is stated to have come from the Eleventh Dynasty temple at Deir-el-Bahri, and may represent one of the Mentuhetep kings, but the provenance is so uncertain that it is difficult to identify it. "When workmen are not well rewarded for the objects found, much is taken away without any record of the original place and connection. If we knew the position to which the figure belonged, the burial chamber, the royal shrine, the family shrines, or elsewhere, we might have fixed the historic value of one of the most striking portraits known from Egypt."

MR. J. BRONTË GATENBY, whose papers on the cytoplasmic inclusions of the germ-cells have formed such a conspicuous feature of the *Quarterly Journal of Microscopical Science* during the last few years, contributes to the last number of that journal (vol. lxiv., part 3) a valuable account of the modern technique of cytology, which, taken in conjunction with his recently published paper on "The Identification of Intra-cellular Elements" (Journal of the Royal Microscopical Society, 1919), should prove of great use to students of microscopical zoology. These papers will place within reach of all many of the numerous modern refinements of technique which are indispensable to future progress, and the use of which bids fair to increase to a very great extent our knowledge of cell morphology and development. We are glad to learn that the author has also undertaken to edit a new edition of that classical and widely appreciated work, Bolles Lee's "Microtomist's Vade Mecum."

IN sending the Report of the Curator of the Somerset County Museum, Taunton Castle, for the year ended September 30, 1919, Mr. H. St. George Gray directs our attention to three graphs showing (1) the annual increase in membership of the Somersetshire Archæological and Natural History Society since 1880; (2) receipts from entrance fees to the museum for the years of this century; (3) fluctuations in the number of visitors during the same period. We are not prepared to admit offhand that this is the first application of graphic curves to society and museum statistics, but the results are undoubtedly illuminating, and, in this case, raise interesting questions for the consideration of those directing the policy of the museum. If such charts, with more frequent time-intervals, were prepared on a consistent plan by all institutions of the kind, their comparison would bring new light to social and economic studies.

THE *Museums Journal* for April–May prints a weighty report on the relation of museums to the advanced student, presented to a British Association Committee by a strong sub-committee. It is claimed that the interests of the serious student should not be sacrificed to those of the general visitor. The needs of the researcher, university student, private student, and collector are considered, and practical recommendations are based on experience. In view of the proposed site of London University, it is interesting to find the report urging closer co-operation between universities and museums. "The student may fairly be asked to help by doing some curatorial work. . . . The museum will profit by the improved arrangement of the objects, and the student will learn how to utilise specimens and how to discover the relevant literature." The student should be supported by "a system of scholarships, held on the double condition of carrying out in the museum research work and curatorial work satisfactory to the professor and the curator respectively."

AN interesting addition to the literature on the subject of the relationship between light and plant-growth appeared recently in the *Journal of Agricultural Research* (vol. xviii., No. 11, March, 1920). In this paper W. W. Garner and H. A. Allard discuss the effect of the relative length of day and night, and of other environmental factors, on growth and reproduction. Their results show that the relative length of the day is a factor of the first importance in plant growth, particularly with respect to sexual reproduction. The effect on sexual reproduction of environmental factors such as temperature, water-supply, etc., seems to be simply one of acceleration or retardation so long as these factors are within a normal range. The seasonal length of day, however, may actually initiate the reproductive processes or inhibit them, according as to whether the given length of day is favourable or unfavourable for the particular species. If the length of day is unfavourable to sexual reproduction, but favourable to growth, then vegetative development is continued indefinitely; but if the length of day is favourable to both reproduction and growth, then the period of sexual reproduction is extended. The seasonal range in the length of day is therefore an important factor in plant distribution, and, moreover, the relation between length of day and reproduction emphasises the great necessity for seeding crops at the proper time.

IN Publication No. 295 of the Carnegie Institution of Washington, entitled "A New Type of Hereditary Brachyphalangy in Man," Messrs. Otto L. Mohr and Chr. Wriedt illustrate the heritability of a trivial character for six generations. The character is a symmetrical shortening of the second joint of the second fingers and toes which recurred without any break for six generations within a Norwegian family, some members of which emigrated to America. Without exception the peculiarity was restricted to the particular phalanx mentioned, the hands and feet being in other respects quite normal. There was no associated shortness of stature. The anomaly manifests itself under two distinctly different somatic types, one "slightly" shortened and generally overlooked by the affected individuals, the other "much" shortened and very striking. No case of an intermediate condition was observed. The brachyphalangy is inherited as a dominant, not as a sex-linked, character. The numerical ratio between the affected and unaffected individuals in the offspring of brachyphalangous members of the family is in accordance with the theoretical Mendelian expectation. All the brachyphalangous individuals are heterozygous for the gene in question, with one possible exception. The material includes a case of identical twins, both showing the same type of brachyphalangy. A genetic explanation of the occurrence of the "slightly" shortened and the "much" shortened types is suggested. The authors are to be congratulated on their careful working out of an interesting case.

ON Friday, June 4, the Association of Economic Biologists and the Imperial Entomological Conference held a joint meeting at the Rothamsted Experimental Station, Harpenden. The greater part of the day was devoted to an examination of the field experiments which were demonstrated by Dr. E. J. Russell and Dr. Winifred E. Brenchley. The park grass plots have been under grass for some centuries; it is not known that seed has ever been sown, and at the beginning of the experiments (1856) the herbage on all the plots was apparently uniform. The twenty-three plots are each manured differently, the same treatment being maintained year after year, and the southern half of each plot is limed. The difference in the vegetation on the several plots is now most remarkable, and, quite apart from the great and immediate practical value of the experiments, they are an ecological demonstration of the very first importance. The Broadbalk wheat field is perhaps the most famous single field in the world. Here wheat has been grown continuously since 1843, the eighteen plots receiving different manurial treatment which has been maintained year after year. The knowledge already yielded by Broadbalk has served almost to revolutionise the earlier ideas concerning the growth and needs of the wheat-plant and the nature of the soil, and the attention now being concentrated upon it by physicist, chemist, statistician, protozoologist, entomologist, mycologist, and algologist should continue the good work begun by Lawes and Gilbert, and so ably sustained by Sir Daniel Hall and the present director. After tea Dr. A. D. Imms opened a discussion on "Tropisms," giving a brief account of his own investigations on chemotropism, and relating these to the general theory of tropisms formulated by Loeb. A paper specially contributed by the latter author was read, and Dr. Tillyard, of New Zealand, Mr. E. E. Green, Dr. Williams, Sir J. C. Bose, Mr. W. B. Brierley, and Prof. Neilson Jones took part in the discussion that followed.

AN interesting case of extreme differentiation of types of igneous rock, in which the whole series is accounted for by gravitational separation, is described concisely by Mr. H. C. Cooke in "The Gabbros of East Sooke" (Canada Geol. Survey, Museum Bull. No. 30, 1919). In view of the use of the mineral name "anorthose" for soda-microcline, objection may be taken to the term "anorthosite" for rocks with felspar akin to anorthite.

PROF. G. CESÀRO sends us a paper on minerals from Monte Somma and Vesuvius, which is of interest as having been prepared for issue in the Bulletin de la Classe des Sciences of the Académie royale de Belgique in 1914, and actually circulated by its author in 1919. Prof. Cesàro has meanwhile, by the stress of war, become personally known to a circle of British mineralogists, who will maintain cordial relations with him despite his return to his own country. As an appendix to the paper Prof. Cesàro describes an apatite from Cornwall as having a low birefringence, and therefore a high fluorine content, and in dealing with similar apatite from Vesuvius he quotes from his previous work the relations between the fluorine present and certain angles of the crystals.

BULLETIN No. 22, part i., of the Geological Survey of New Zealand, on the limestone resources of the country, by Mr. P. G. Morgan, is really a treatise on limestone and its uses, illustrated from occurrences in New Zealand. It is thus exactly suited to local requirements; but both it and its successor on the phosphates will be welcomed in a much wider field. Attention is well given to the use of lime and of ground limestone on the land. The literature to be consulted is wide, but we note that all the papers named as of a general character are of American origin. We thus miss the work of Messrs. Hutchinson and MacLennan at Rothamsted, published in the *Journal of Agricultural Science* in 1915. Mr. J. A. Hanley's account of his experiments with various limes in Yorkshire (Journ. Soc. Chem. Indust., 1918) is probably too recent for inclusion, since communications have been disturbed by war; but for some years past there have been indications that authors and publishing bodies in the United States have been more mindful than ourselves of libraries in the Pacific region. This should be a reminder for Britons, who are the true begetters of the enterprising island folk.

THE Executive Committee of the Advisory Council of Science and Industry of the Commonwealth of Australia has issued the third and concluding part of an exhaustive report by Dr. F. L. Stillwell upon the factors influencing gold deposition in the Bendigo goldfield. As is well known, the mode of occurrence of the gold reefs in this field is quite unique, and its peculiarities have given rise to much discussion, so that the thorough investigation here presented should be of great interest to all students of mineral deposits. The general conclusions arrived at are that the form of the reefs is due primarily to that of the original fracture through which the depositing solutions have percolated; that all the large and important reefs have been in some way associated with faults, the latter being generally contemporaneous and connected with the folding of the rocks, the faults having given rise to a network of fractures which afforded a passage to the mineralising solutions; and that the deposition of the gold from these solutions has been brought about in three ways: (1) Precipitation from the auriferous solution; (2) crystallisation from a supersaturated solution; and (3) crystallisation from solutions the supersaturation of which is due to decreasing temperature after the main portion of the gold has been precipitated. The first of these is the most important method of deposition, and appears to be closely connected with the presence of carbonaceous matter.

IN his address to the Royal Geographical Society at the anniversary meeting on May 31, Lt.-Col. Sir Francis Younghusband pleaded for a wider outlook in geography and freedom from a strictly utilitarian viewpoint. A knowledge of the beauty of the earth may be legitimately included within the scope of geographical science. Beauty of scenery in many instances is the most noteworthy characteristic of a country and its most valuable asset. Advertisements of tourist organisations, railway and steamship companies, and even emigration departments, bear constant witness to the importance of this aspect. Moreover, natural beauty is inexhaustible, while mineral wealth is limited and agricultural productivity not unbounded. Sir Francis Younghusband contended that the geographical knowledge of a country was incomplete without a knowledge of its beauty, and that by this means alone can the geographer gain a sense of the earth "as live, supple, sensitive, and active." Continuing, he pointed out that there should be less hesitation in accepting this principle when it is realised that natural beauty affects the movements of man, and that man is having an increasing effect on natural beauty, often, but not always, with disastrous results. This relationship between man and the beauty of the earth is one of which geography should take as much cognisance as it does of the relationship between man and the productivity of the earth. The knowledge of beauty must be carefully gathered. Careless snapshots and shallow rhapsodies in guide-book style are unsatisfactory. We require the best photographs as well as paintings and accurate descriptions of literary merit. The artist both in pencil and in words is essential in geographical work.

IN the *Meteorological Magazine* for May a notice is given of the circulation of forecasts by wireless telegraphy from collective weather reports for London and south-east England. Hourly reports of meteorological information prepared by the Forecast Service of the Meteorological Office are sent out from the wireless station at the Air Ministry. The message is given in a code form, which is practically the same as that prescribed in Annex G of the "Convention relating to International Air Navigation," Paris, 1919. The forecasts, which are being issued eight times a day, are based on observations taken about half an hour before the time of issue. Detailed explanation of the code can be obtained on application at the Meteorological Office. A new device is also mentioned for making the meteorological reports rapidly available to the public. A large weather map is exhibited daily at the Air Ministry in one of the front windows on the ground floor of Empire House, Kingsway. All the principal reporting stations in the British Isles, as well as a few neighbouring Continental ones, are marked on the chart, which is on the Mercator projection, and is 10 ft. high and 6 ft. wide. The information on the chart is changed at about 3h., 8h. 30m., and 14h. 30m. G.M.T., the data exhibited referring to observations made at 1h., 7h., and 13h. G.M.T. The exceptionally wet character of April is well shown in the Thames Valley Rainfall Map, where upwards of 5 in., and in places more than 6 in., of rain occurred during the month over the western portion of the valley. Districts with less than 3 in. are rare, and almost entirely confined to the neighbourhood extending from London to the mouth of the Thames. In England and Wales the general rainfall for April was 204 per cent. of the average.

FOR many years the utilisation of the water-power of the Rhone has attracted attention in France. The shortage of coal has renewed interest in the problem, which is now on the road to solution. The Chamber of Deputies has taken the matter in hand, and agreed to proposals which now await consent by the Senate. According to an article by M. M. Fourniols published in the *Revue générale des Sciences* for May 15, the plan is to divide the river into six sections, to be managed separately or preferably by a single body. Concessions are to be for seventy-five years' duration, and will be helped by State loans. Besides the utilisation of water-power, the project embraces the improvement of navigation, the creation of river ports, and the construction of irrigation works. At present the conditions are not favourable for navigation, but the recently opened canal from Marseilles to Arles opens a new vista of possibilities in cheap river connections with the sea. It is proposed to erect a number of power stations between Genissiat, near the Swiss frontier, and Comps, near Tarascon. Genissiat with 200,000 h.p. will be the largest, and will probably supply power to Paris. Other important stations will be near Lyons, Valence, Montelimar, and Mondragon. A form of dam and locks is projected which will interfere as little as possible with navigation.

IN an article in the *Revue Scientifique* for May 22 M. A. de Gramont de Guiche, president of the council of the Institute of Optics of France, describes the arrangements made for the first session of the institute, April to July, of the present year. The institute is divided into three sections: (1) A school of higher studies intended to provide the training requisite for the specialists in the subject; (2) a laboratory for research and practical instruction; and (3) a school for the training of the workmen and craftsmen both in glass- and in instrument-making. At the opening of the course on April 12 M. Jobin, one of the members of the council, described in detail the objects of the institute and the steps that were being taken to carry out those objects, and Dr. Dunoyer gave the first lecture of a course on optical instruments. Other lecture courses are provided on "The Calculation of Optical Systems," "Spectroscopy," "Glass: Its Nature and its Applications," "The Applications of Polarised Light," "The Microscope," and "The Properties of X- and γ-Rays." The fee for the session is 150 francs, and, although no one is excluded, it is pointed out that to profit as much as possible from the course students should have a fair knowledge of mathematics.

IN a paper published in the *Mathematical Gazette* for 1919–20 Dr. S. Brodetsky, reader in applied mathematics in the University of Leeds, brings forward a graphical treatment of differential equations as of special value in certain cases which are not soluble by the usual analytical methods and as of general value for purposes of instruction. There is justice in his view that the average student of mathematics regards the usual methods of solution as a series of tricks which he learns to apply with more or less success to such equations as are presented to him. A graphical treatment cannot fail to be of great value in teaching the meaning of differential equations and in giving the student confidence in their use. The paper contains numerous examples, and illustrates the meaning of singular solutions, cusp loci, etc. Not the least interesting example is the solution of the equation

$$\frac{dy}{dx} = -\frac{x}{y} - (x^2+y^2)^{\frac{1}{2}},$$

which occurred in discussing the motion of a plane lamina moving in air under the earth's attraction—one of the simple types of aeroplane motion. The equation was insoluble by any of the standard methods, but easily soluble graphically.

DURING the war considerable quantities of acetone were prepared by the fermentation of starchy material. Hitherto, however, no investigation of the mechanism of this fermentation has been described, and Messrs. J. Reilly, W. J. Higginbottom, F. R. Henley, and A. C. Thaysen publish in the April issue of the *Biochemical Journal* an account of a quantitative examination of the process. These authors find that the fermented mash contains varying proportions of acetic and butyric acids, the ratio of the latter to the former increasing with the increase (during fermentation) in the acidity of the mash and reaching a maximum at the stage of greatest acidity. Not until the latter stage is reached are appreciable quantities of acetone and *n*-butyl alcohol produced. With the production of "oil" the ratio of butyric to acetic acid diminishes, and finally the mash contains an excess of acetic acid. During the period of the increase of acidity of the mash the rate of gas evolution rises steadily for some time, then becomes constant; and as the acidity falls the rate of gas evolution rises quickly to a maximum, and then falls rapidly until the end of the fermentation. The gas consists of hydrogen and carbon dioxide in a proportion varying from 3 : 1 at first to 2 : 3 at the latter part of the fermentation. It is extremely probable that acetic and butyric acids are not the only acids formed, and evidence is given of the presence of an acid less volatile in steam. Lactic acid results from the type of infection most frequently observed. If the fermentation is carried out in the presence of calcium carbonate it proceeds as far as the point of maximum acidity, but the production of acetone and *n*-butyl alcohol is almost entirely suppressed.

IN the *Wiener Denkschriften* (Math.-Naturwiss. Kl., Bd. 96, pp. 671–750, 1919) Dr. A. Defant continues his important researches on tides in landlocked and border seas, bays, and channels. After a theoretical discussion of the influence of friction against the ocean-bed in channels, he deduces an average value of the coefficient of skin friction from a consideration of the tides in the Gulf of Suez and in certain lakes which exhibit seiches. He then enters upon a careful detailed study of the tides in the English Channel, using a step-by-step numerical method for the solution of the differential equations of the tides between successive cross-sections of the Channel. He thus succeeds in demonstrating the truth of a conjecture made long ago by Airy to the effect that the complicated tides of the Channel are governed mainly by the definite tidal oscillations of the Atlantic Ocean and the North Sea at the two ends of the Channel; this view had been contested by Börgen, but the consequences of the view were misinterpreted by the latter. Dr. Defant shows that not only the co-tidal lines and tidal ranges, but also the phase and speed of the tidal currents in the Channel, can be explained on the basis of Airy's ideas, taking surface friction at the channel-bed into account, and also the rotation of the earth. He finds that the latter affords an explanation of why the tidal range on the French coast of the Channel is greater than that on the English coast. For the sections of the Channel near the east opening into the North Sea the calculations cannot be executed with the accuracy elsewhere obtained, owing to the approximation of the ocean-tidal period to the free period of lateral oscillation across this broad part of the Channel. But even here the chief features can be derived by interpolation, and throughout the remainder of the Channel all the important features of the complex Channel tides receive satisfactory theoretical explanation.

THE paper read by Gen. Squier to the U.S. National Academy on April 27 on "Multiplex Telephony and Telegraphy over Open-circuit Bare Wires Laid in the Earth or Sea" has excited great interest amongst radio-telegraphists, who find it difficult to make out whether we are on the eve of important developments or not. Gen. Squier has established communication for a distance of three-quarters of a mile over the Potomac River by means of a bare No. 12 phosphor-bronze wire laid directly in the water. The transmitter consisted of an electron tube oscillator, which produced a current of about 270 milliamperes at a frequency of 600,000. At the receiving end of the line an electron tube and a six-stage amplifier were used without any earth connection. With this arrangement good tuning could be obtained at either end of the line, and satisfactory telegraphic and telephonic transmissions secured by means of the bare wire immersed in fresh-water. In another experiment telegraphic and telephonic transmission were obtained between two stations three-quarters of a mile apart by means of a No. 16 copper wire buried in the earth to a depth of about 8 in. It will be seen that if the method develops satisfactorily it will have commercial possibilities. The best Atlantic cable cannot operate at a frequency greater than 10 per second, and 80 volts is the highest voltage that can be applied to work it. There is scope, therefore, for development in submarine telegraphy. Gen. Squier suggests that experiments should be made with bare wires in sea-water to determine what arrangement will give the best results. He points out that with this method there will be no distortion of the signals, and so there is no limit to the distance of transmission, and the receiving apparatus will be comparatively simple. It is also possible to transmit simultaneously several signals, both telephonic and telegraphic, over the same wire by using different frequencies. The method is an attractive one, and seems to have arrived at the stage where commercial research can usefully be started.

Our Astronomical Column.

PHOTOGRAPHS OF THE BRORSEN-METCALF COMET.—The *Astrophysical Journal* for March contains some photographs of this comet taken by Prof. Barnard on 1919 October 5, 6, 20, and 22. The tail is shown as fully 6° long, composed of several narrow straight streamers forming a fan. They radiate from a point somewhat behind the centre of the head. About October 20 the comet discarded its tail, and formed a new one inclined 12° to the old. Prof. Barnard notes that similar phenomena have been observed in Borrelly's comet, 1903 July 24, in Morehouse's comet on several dates in 1908, and in Halley's comet on 1910 June 6 (probably also in April).

In each case the new tail appears to move out faster than the rear portion of the old tail. Prof. Barnard conjectures that the latter is formed of larger particles, the motion of which would be slower.

He has combined successive cometary photographs in the stereoscope in the endeavour to determine the configuration of the tail in three dimensions. Care is, of course, required to distinguish true stereoscopic effects from spurious ones. It is stated that the tail of Morehouse's comet on October 15, 1908, resembled "part of an open sack, or a partly opened scroll."

THE PLANETARY FAMILIES OF COMETS.—The report of the nineteenth meeting of the American Astronomical Society contains a paper on this subject by Prof. H. N. Russell. He notes that the orbits of the six comets of the Neptune group all pass considerably closer to the orbits of Jupiter and Saturn than they do to that of Neptune. His first conclusion was that these comets had been captured not by Neptune, but by Jupiter. He analysed the orbits of the periodic comets with the following result:—

Thirty-six comets on his list have periods of less than ten years. The orbits of all these, except Encke's, pass within 0·65 of Jupiter's orbit, while seventeen of them pass within 0·15 of it.

Thirty-one comets have periods between ten and one thousand years. Of these, seven pass within 0·5 of Jupiter's orbit, five within the same distance from Saturn's orbit, and two within this distance from Uranus's orbit, the nearest approach to Neptune's orbit being 1·22.

Prof. Russell has calculated the proportion of the thirty-one comets that would pass within 0·5 of each orbit on the hypothesis of chance approach, and finds that it is six for Jupiter, three for Saturn, one and a half for Uranus, and one for Neptune. Hence he concludes that the observed figures give little evidence of capture by any of the planets.

There is, however, a point not noticed by Prof. Russell, which is that the periods under a century range themselves into four definite groups, the mean period of each group being about 0·4 of that of one of the giant planets. This gives strong ground for postulating a connection with these planets. Since Halley's comet has been observed for more than two thousand years, there is no difficulty in assigning to it a life dating back to the time when its orbit intersected that of Neptune. The longer the period of a comet the less frequent are the occasions when it is subject to serious disruptive influences, and consequently its disintegration is likely to be less rapid. It appears to the writer of this note that Proctor's suggestion that the periodic comets are the products of eruptions from the giant planets deserves more attention than it has generally received.